

LA Darling Pumping Test Presentation of Data Talking Points
Meeting with MDEQ and EPA
September 28, 2017

1. Pumping test was conducted between April 28 to May 1, 2017
 - a. The test was conducted by pumping from TW-1 at a rate of 225 GPM (**Figure 1**).
 - b. The pumping test was conducted over a 72-Hour period.
 - c. Discharge water was pumped into a 22,000 gallon frac tank, then from the frac tank through a mobile carbon adsorption treatment system, and discharged to the City of Bronson sanitary sewer.
 - d. Drawdown monitoring was conducted using a combination of automatic and manual methods. Automatic monitoring was conducted using Leveltroll 700 pressure transducers set in monitoring points as listed on **Table 1 & Figure 1**. Manual monitoring was conducted at locations as listed on **Table 2 & Figure 1**.
2. Following the pumping test, the pressure transducer data was downloaded and analyzed using Aquifer Test Pro, v. 2016.
 - a. Type Curve matching of data generated by pressure transducers was conducted through the use of the Aquifer Test Pro software using the Neumann Analytical Method for unconfined aquifers. The data generated included determination of the aquifer's hydraulic conductivity, transmissivity, specific yield, Kv/Kh ratio, and Sy/S ratio.
 - b. Software input parameters included the aquifer thickness (47 Ft), well construction details and locations relative to state plane coordinates, units of measurement, and groundwater static elevation prior to the test.
3. The analytical results of the pumping test, as analyzed at each monitoring point, show the following as presented in **Table 1**.
 - a. The conductivity of the aquifer ranges from 22.8 Ft/Day to 4410 Ft/Day.
 - b. The transmissivity of the aquifer ranges from 1070 FT²/Day to 207000 Ft²/Day.
 - c. The specific yield of the aquifer ranges from 0.147 to 333000.
 - d. The ratio of Kv/Kh of the aquifer ranges from 0.00425 to 10000.
 - e. The ratio of Sy/S of the aquifer ranges from 11.5 to 574000.
 - f. Drawdown in the aquifer was observed at every monitoring location (**Table 2**).
4. Because the range of values derived through the analysis of data using Aquifer Test Pro is so great from the lowest values to the highest values for each aquifer property, a "box - whisker" statistical graph was developed and presented in tabular form to identify data outliers (**Table 3**). After removal of the data outliers, the remaining values of each of the aquifer properties was averaged in the analysis. The statistical analysis shows the following results as presented on **Table 3**.
 - a. The average conductivity value of the aquifer is 766 Ft/Day.
 - b. The average transmissivity value of the aquifer is 36041 Ft²/Day.
 - c. The average specific yield of the aquifer is 0.434.
 - d. The average ratio of Kv/Kh of the aquifer is 0.896.
 - e. The average ratio of Sy/S of the aquifer is 59.356.

5. These average values were input into the Aquifer Test Pro model for the predictive analysis of capture zones and aquifer mounding at upgradient injection points. Several scenarios of capture and injection were analyzed. The predictive analysis shows the following as the most optimum aquifer management scenario.
 - a. A network of seven extraction wells with six of the wells situated approximately 35 feet east of the west property boundary and one well situated approximately 145 feet east of the west property boundary and approximately 15 feet south of the northern property boundary (**Figure 2**).
 - i. EW-1; 10 GPM
 - ii. EW-2; 10 GPM
 - iii. EW-3; 15 GPM
 - iv. EW-4; 10 GPM
 - v. EW-5; 10 GPM
 - vi. EW-6; 15 GPM
 - vii. EW-7; 10 GPM
 - b. The predictive analysis shows that with an 80 GPM total dynamic flow, capture of groundwater is attained before water leaves the LA Darling property (**Figure 2**). Extraction from each well is as follows:
 - i. EW-1; 10 GPM
 - ii. EW-2; 10 GPM
 - iii. EW-3; 15 GPM
 - iv. EW-4; 10 GPM
 - v. EW-5; 10 GPM
 - vi. EW-6; 15 GPM
 - vii. EW-7; 10 GPM
 - c. A network of 5 injection wells with three injection wells situated approximately 30 feet west of the eastern property boundary on the south side of Railroad Street, and two injection wells situated approximately 65 feet west of the eastern property boundary on the north side of Railroad Street (**Figure 2**).
 - d. The predictive analysis shows that with a 50 GPM total dynamic injection flow, Groundwater mounding is contained (**Figure 3**). Injection at each well location is as follows:
 - i. IW-1; 10 GPM
 - ii. IW-2; 10 GPM
 - iii. IW-3; 10 GPM
 - iv. IW-4; 10 GPM
 - v. IW-5; 10 GPM

Table 1
Well Construction Details; Radial Distance & Observed Maximum Drawdowns; and Aquifer Properties
Pumping Test 2; April 28 Through May 1, 2017

Well Name	Screen Interval (Ft)	Screen Length (Ft)	Maximum Drawdown (Ft)	Radial Distance (Ft)	Conductivity (Ft/Day)	Transmissivity (Ft ² /Day)	Specific Yield	Kv/Kh	Sy/S
OW-2	27.5 - 32.5	5	0.923	36.62	677	31800	0.264	0.168	185
AS-4D	35 - 40	5	0.43	41.65	896	42100	0.259	0.0865	124
AS-7S	20 - 25	5	0.579	25.56	552	25900	0.666	0.0987	40.1
AS-7D	40 - 45	5	0.542	26.44	1040	48900	0.559	0.00425	29.1
AS-8S	20 - 25	5	0.399	59.89	1010	47700	0.147	0.0566	16.7
MW-3S	9 - 14	5	0.803	7.28	677	31800	0.583	1	11.5
MW-3I	28 - 33	5	0.431	6.93	1730	81300	0.686	4.39	13
MW-3D	50 - 55	5	0.72	4.85	4410	207000	15.800	0.0509	13.9
TW-1*	12 - 42	30	2.014	0	22.8	1070	333000	10000	574000
OW-1*	27.5 - 32.5	5	3.207	15.21	294	13800	0.310	2.21	100

* Aquifer values derived from analysis of the initial 19 hours of the first (aborted) pumping test.

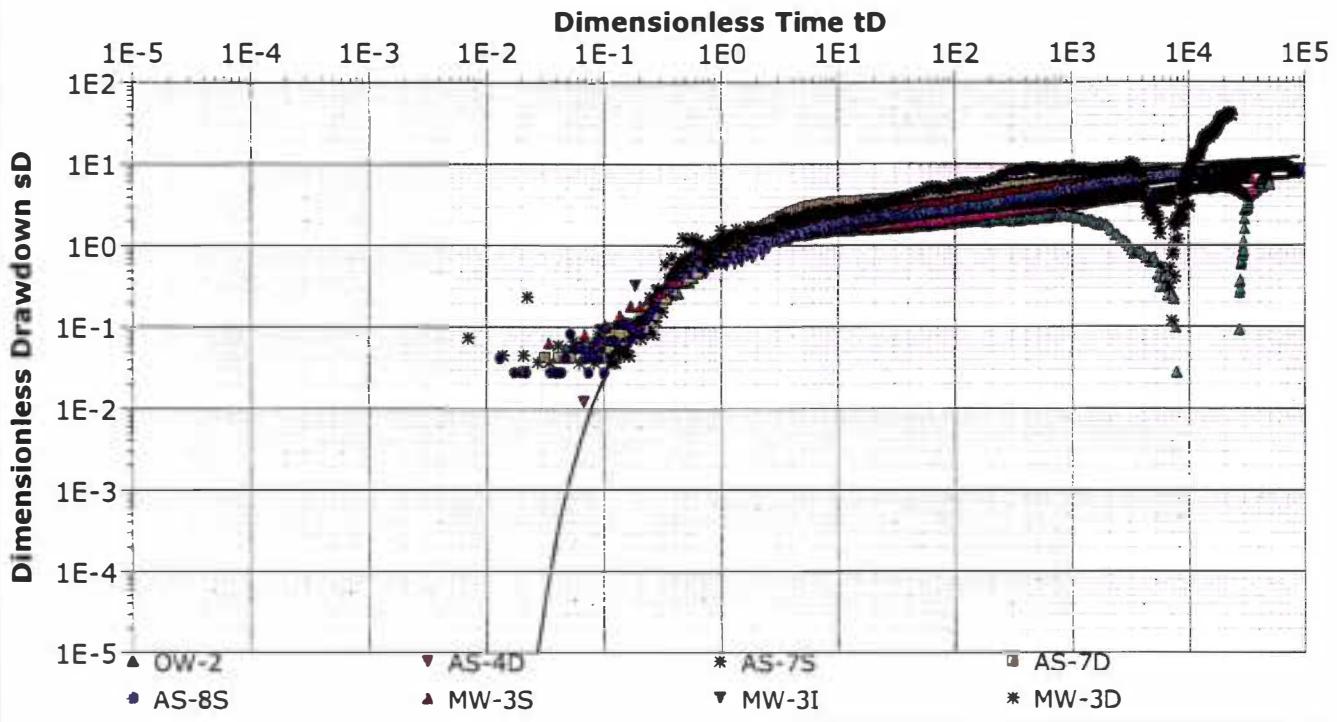
Table 2
Depth to Water Readings and Groundwater Elevations
April 19, 2017 Through May 10, 2017

NAME	TOC	DTW	GW ELEVATION	DTW	GW ELEVATION	DTW	GW ELEVATION	DTW	GW ELEVATION						
		4/19/2017		4/24/2017		4/28/2017		4/30/2017		5/1/2017		5/3/2017		5/10/2017	
IW-1S	914.27			8.71	905.56	8.82	905.45	9.04	905.23	8.95	905.32	8.87	905.40	8.78	905.49
IW-1I	914.35			8.79	905.56	8.81	905.54	9.10	905.25	9.02	905.33	8.94	905.41	8.85	905.50
IW-1D	914.27			8.70	905.57	8.89	905.38	9.02	905.25	8.94	905.33	8.86	905.41	8.76	905.51
IW-2S	916.14	10.56	905.58	10.56	905.58	10.78	905.36	11.04	905.10	10.96	905.18	10.75	905.39	10.66	905.48
IW-2I	915.34	9.94	905.40	9.98	905.36	10.08	905.26	10.43	904.91	10.35	904.99	10.13	905.21	10.05	905.29
IW-2D	915.98	10.40	905.58	10.45	905.53	10.55	905.43	10.90	905.08	10.81	905.17	10.60	905.38	10.51	905.47
IW-3S	913.40	7.84	905.56	7.88	905.52	7.99	905.41	8.79	904.61	8.70	904.70	8.03	905.37	7.95	905.45
IW-3I	913.41	7.87	905.54	7.91	905.50	8.02	905.39	8.73	904.68	8.65	904.76	8.07	905.34	7.97	905.44
IW-3D	913.33	7.79	905.54	7.84	905.49	7.94	905.39	8.45	904.88	8.35	904.98	7.99	905.34	7.90	905.43
IW-4S	913.23	7.65	905.58	7.70	905.53	7.79	905.44	8.08	905.15	8.00	905.23	7.85	905.38	7.76	905.47
IW-4I	913.24	7.66	905.58	7.71	905.53	7.80	905.44	8.09	905.15	8.00	905.24	7.86	905.38	7.77	905.47
IW-4D	913.21	7.62	905.59	7.67	905.54	7.76	905.45	8.05	905.16	7.96	905.25	7.82	905.39	7.73	905.48
IW-5S	916.11			10.60	905.51	10.69	905.42	10.97	905.14	10.88	905.23	10.74	905.37	10.65	905.46
IW-5I	916.13			10.61	905.52	10.72	905.41	10.98	905.15	10.90	905.23	10.76	905.37	10.67	905.46
IW-5D	916.09			10.58	905.51	10.68	905.41	10.94	905.15	10.87	905.22	10.73	905.36	10.64	905.45
IW-6S	912.16	6.58	905.58	6.62	905.54	6.72	905.44	6.94	905.22	7.85	904.31	7.77	904.39	6.69	905.47
IW-6I	912.38	6.73	905.65	6.79	905.59	6.88	905.50	7.10	905.28	7.07	905.31	6.93	905.45	6.85	905.53
IW-6D	912.37	6.73	905.64	6.78	905.59	6.88	905.49	7.11	905.26	7.02	905.35	6.93	905.44	6.85	905.52
IW-7S	912.32			7.37	904.95	7.47	904.85	7.64	904.68	7.55	904.77	7.53	904.79	7.44	904.88
IW-7I	912.45			7.15	905.30	7.24	905.21	7.40	905.05	7.32	905.13	7.30	905.15	7.21	905.24
IW-7D	912.45			7.28	905.17	7.39	905.06	7.54	904.91	7.46	904.99	7.44	905.01	7.35	905.10
IW-21	918.05			12.49	905.56	12.59	905.46	12.84	905.21	12.76	905.29	12.63	905.42	12.54	905.51
OW-1	915.87	10.34	905.53	10.39	905.48	10.49	905.38	11.12	904.75	11.03	904.84	10.53	905.34	10.44	905.43
OW-2	915.84	10.30	905.54	10.35	905.49	10.46	905.38	10.95	904.89	10.86	904.98	10.51	905.33	10.41	905.43
AS-4S	914.69	9.13	905.56	9.17	905.52	9.28	905.41	9.73	904.96	9.65	905.04	9.33	905.36	9.23	905.46
AS-4I	914.66	9.12	905.54	9.16	905.50	9.27	905.39	9.70	904.96	9.61	905.05	9.31	905.35	9.22	905.44
AS-5S	915.00	9.42	905.58	9.47	905.53	9.57	905.43	9.91	905.09	9.83	905.17	9.62	905.38	9.53	905.47
AS-5D	914.95	9.39	905.56	9.44	905.51	9.54	905.41	9.88	905.07	9.79	905.16	9.59	905.36	9.50	905.45
AS-6S	914.80	9.22	905.58	9.27	905.53	9.37	905.43	9.65	905.15	9.56	905.24	9.42	905.38	9.33	905.47
AS-7S	914.84	9.33	905.51	9.35	905.49	9.46	905.38	10.01	904.83	9.94	904.90	9.50	905.34	9.41	905.43
AS-7D	914.85	9.30	905.55	9.37	905.48	9.47	905.38	10.00	904.85	9.92	904.93	9.51	905.34	9.43	905.42
AS-8S	915.06	9.51	905.55	9.56	905.50	9.66	905.40	10.05	905.01	10.04	905.02	9.70	905.36	9.62	905.44
AS-8D	915.14	9.59	905.55	9.64	905.50	9.74	905.40	10.12	905.02	9.97	905.17	9.79	905.35	9.70	905.44
AS-9S	915.11	9.54	905.57	9.59	905.52	9.69	905.42	10.00	905.11	9.91	905.20	9.73	905.38	9.65	905.46
AS-9D	915.05	9.48	905.57	9.53	905.52	9.63	905.42	9.94	905.11	9.85	905.20	9.68	905.37	9.60	905.45
SFMW-3S				9.72		9.83		10.15		10.07		9.88		9.78	
SFMW-3I				9.82		9.91		10.24		10.16		9.96		9.87	
SFMW-3D				9.82		9.93		10.25		10.16		9.97		9.88	
SG-1	905.84	1.06	904.78	1.12	904.72	1.16	904.68	1.13	904.71	0.96	904.88	1.09	904.75	1.11	904.73
SG-2	908.52	2.69	905.83	2.72	905.80	2.80	905.72	2.74	905.78	5.56	902.96	2.72	905.80	2.74	905.78

Table 3
Well Construction Details; Radial Distance & Observed Maximum Drawdowns; and Aquifer Properties
Pumping Test 2; April 28 Through May 1, 2017: Statistical Analysis of Data

Well Name	Screen Interval (Ft)	Screen Length (Ft)	Maximum Drawdown (Ft)	Radial Distance (Ft)	Conductivity (Ft/Day)	Transmissivity (Ft ² /Day)	Specific Yield	Kv/Kh	Sy/S
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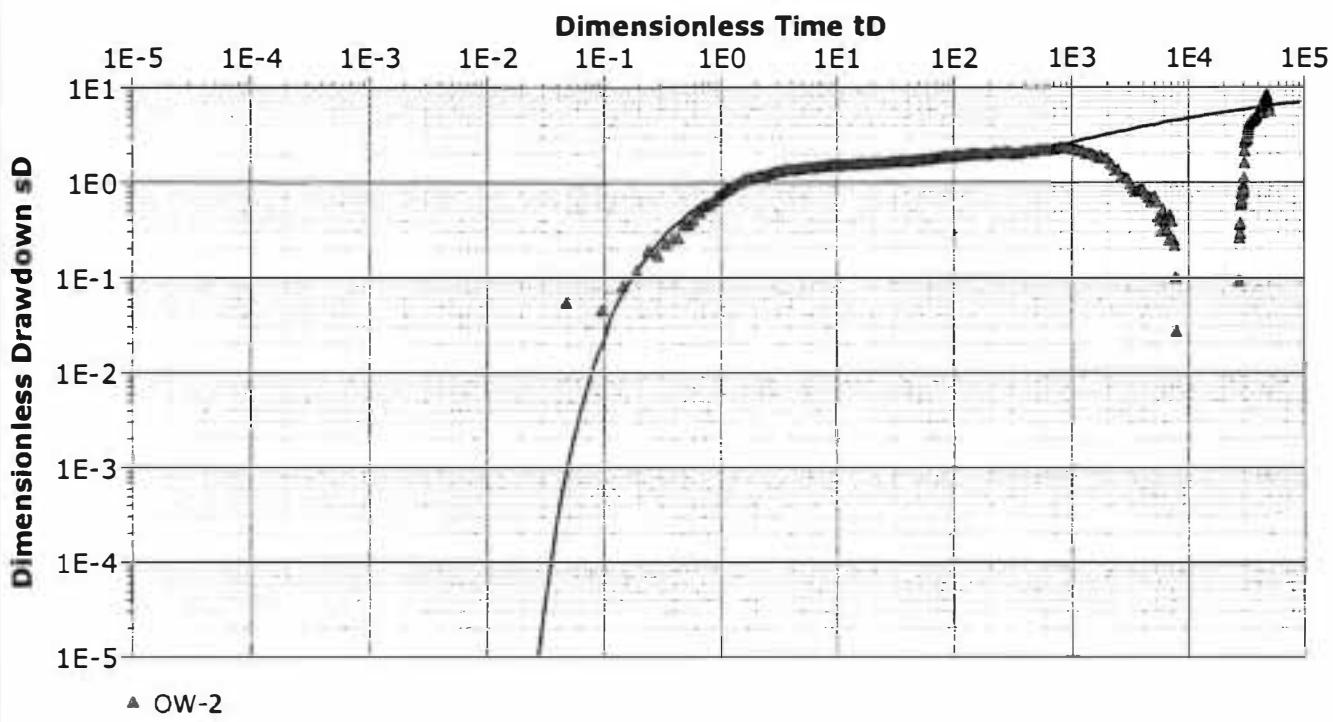
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		Project: LA Darling Pumping Test 2
		Number:
		Client: Darling Store Fixtures
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1
Test Conducted by: Bade		Test Date: 4/28/2017
Analysis Performed by: Bade	All Modified	Analysis Date: 7/17/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]	



Calculation using Neuman

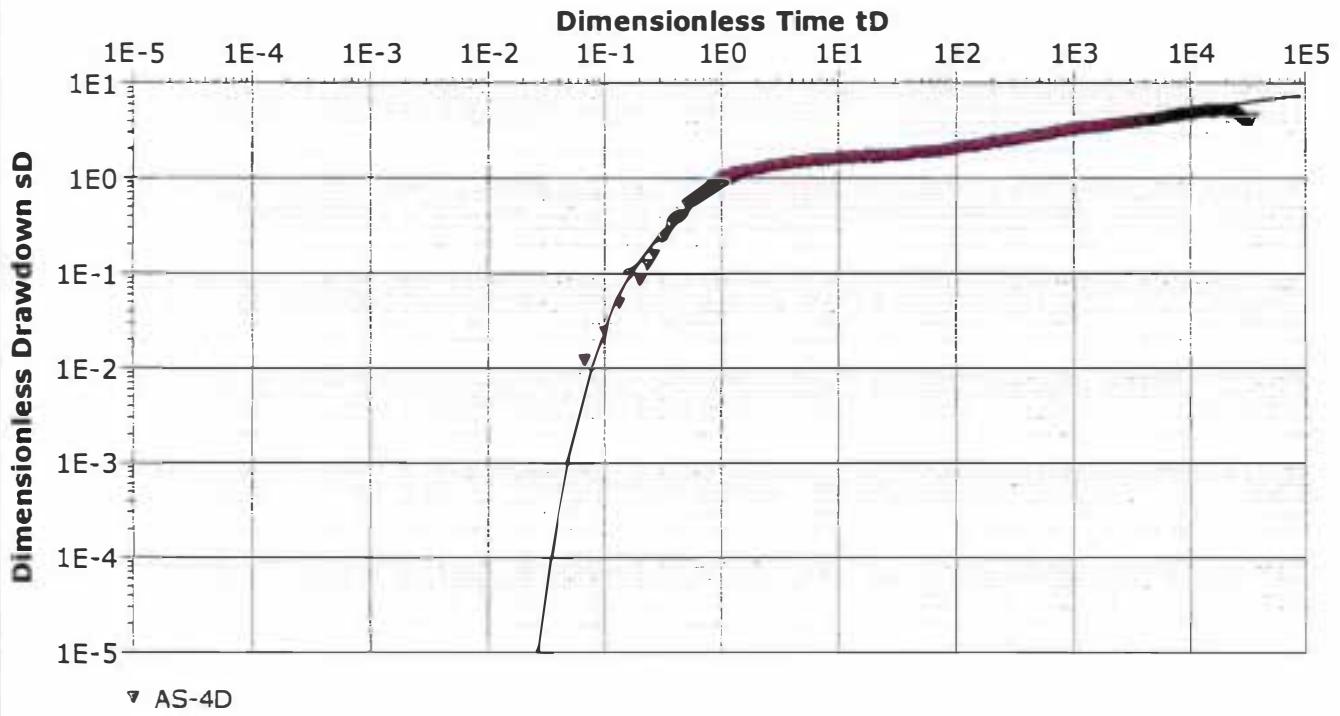
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
OW-2	3.18×10^4	6.77×10^2	2.64×10^{-1}	1.68×10^{-1}	1.85×10^2	36.62
AS-4D	4.21×10^4	8.96×10^2	2.59×10^{-1}	8.65×10^{-2}	1.24×10^2	41.65
AS-7S	2.59×10^4	5.51×10^2	6.66×10^{-1}	9.87×10^{-2}	4.01×10^1	25.56
AS-7D	4.89×10^4	1.04×10^3	5.59×10^{-1}	4.25×10^{-3}	2.91×10^1	26.44
AS-8S	4.77×10^4	1.01×10^3	1.47×10^{-1}	5.66×10^{-2}	1.67×10^1	59.89
MW-3S	3.18×10^4	6.77×10^2	5.83×10^{-1}	1.00×10^0	1.15×10^1	7.28
MW-3I	8.13×10^4	1.73×10^3	6.86×10^{-1}	4.39×10^0	1.30×10^1	6.93
MW-3D	2.07×10^5	4.41×10^3	1.58×10^1	5.09×10^{-2}	1.39×10^1	4.85
Average	6.46×10^4	1.37×10^3	2.37×10^0	7.31×10^{-1}	5.42×10^1	

		Pumping Test Analysis Report
		Project: LA Darling Pumping Test 2
		Number:
		Client: Darling Store Fixtures
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1
Test Conducted by: Bade	Test Date: 4/28/2017	
Analysis Performed by: Bade	OW-2 Modified	Analysis Date: 7/17/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]	



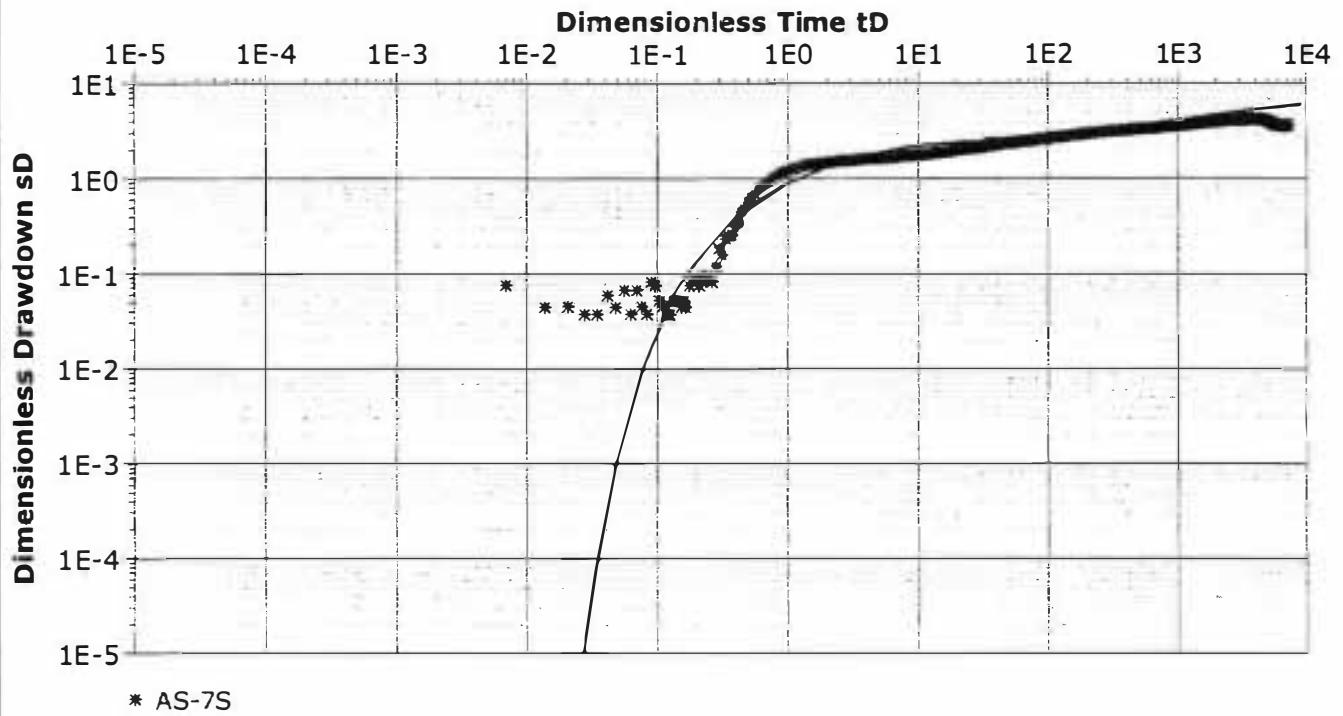
Calculation using Neuman						
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
OW-2	3.18×10^4	6.77×10^2	2.64×10^{-1}	1.68×10^{-1}	1.85×10^2	36.62

		Pumping Test Analysis Report	
Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1		Pumping Well: TW-1
Test Conducted by: Bade			Test Date: 4/28/2017
Analysis Performed by: Bade	AS-4D Modified		Analysis Date: 7/17/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman						
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
AS-4D	4.21×10^4	8.96×10^2	2.59×10^{-1}	8.65×10^{-2}	1.24×10^2	41.65

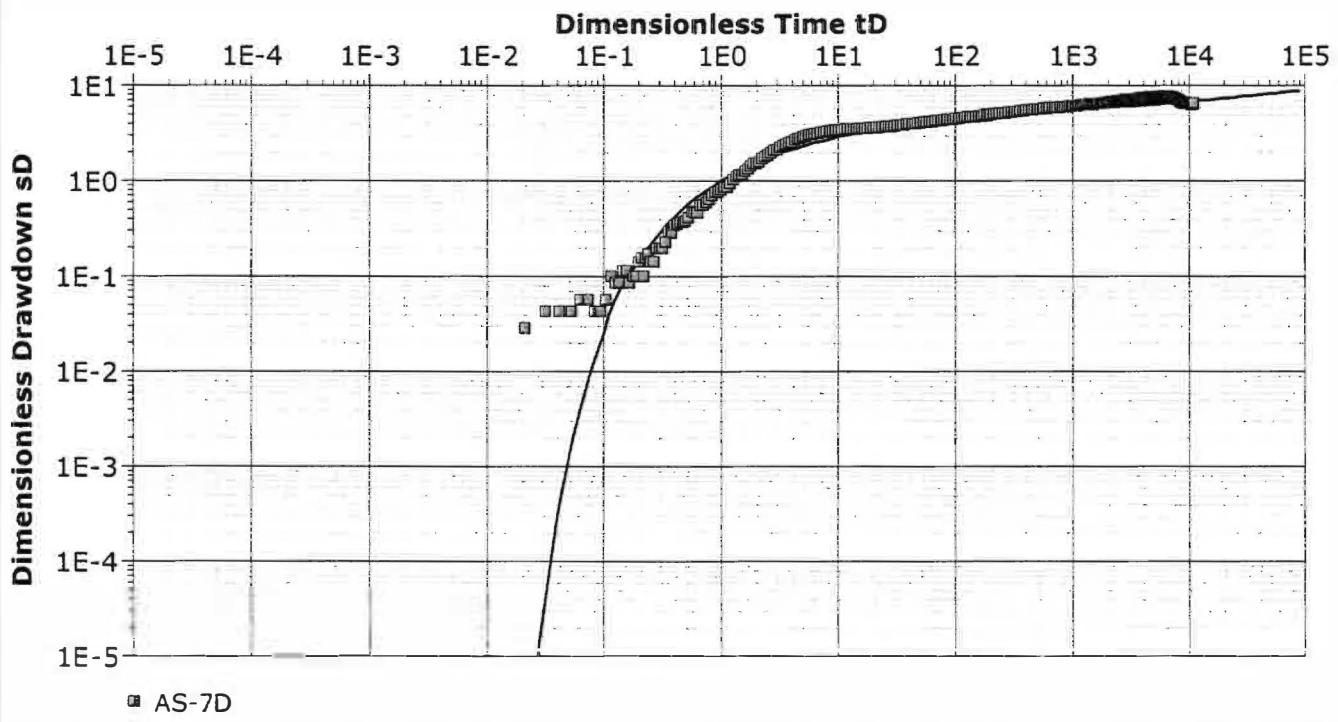
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Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1	
Test Conducted by: Bade		Test Date: 4/28/2017	
Analysis Performed by: Bade	AS-7S Modified	Analysis Date: 7/17/2017	
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman

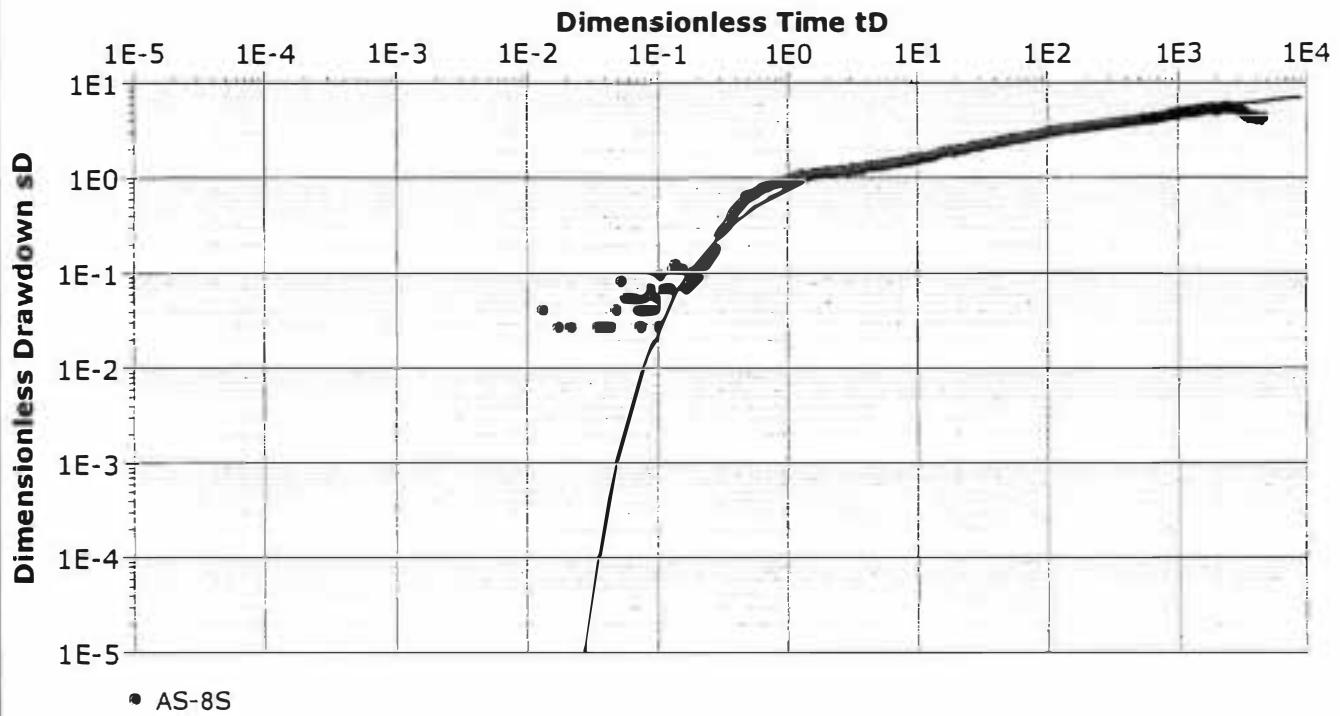
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
AS-7S	2.59×10^4	5.52×10^2	6.66×10^{-1}	9.87×10^{-2}	4.01×10^1	25.56

		Pumping Test Analysis Report	
Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1		Pumping Well: TW-1
Test Conducted by: Bade			Test Date: 4/28/2017
Analysis Performed by: Bade	AS-7D Modified		Analysis Date: 7/17/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman						
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
AS-7D	4.89×10^4	1.04×10^3	5.59×10^{-1}	4.25×10^{-3}	2.91×10^1	26.44

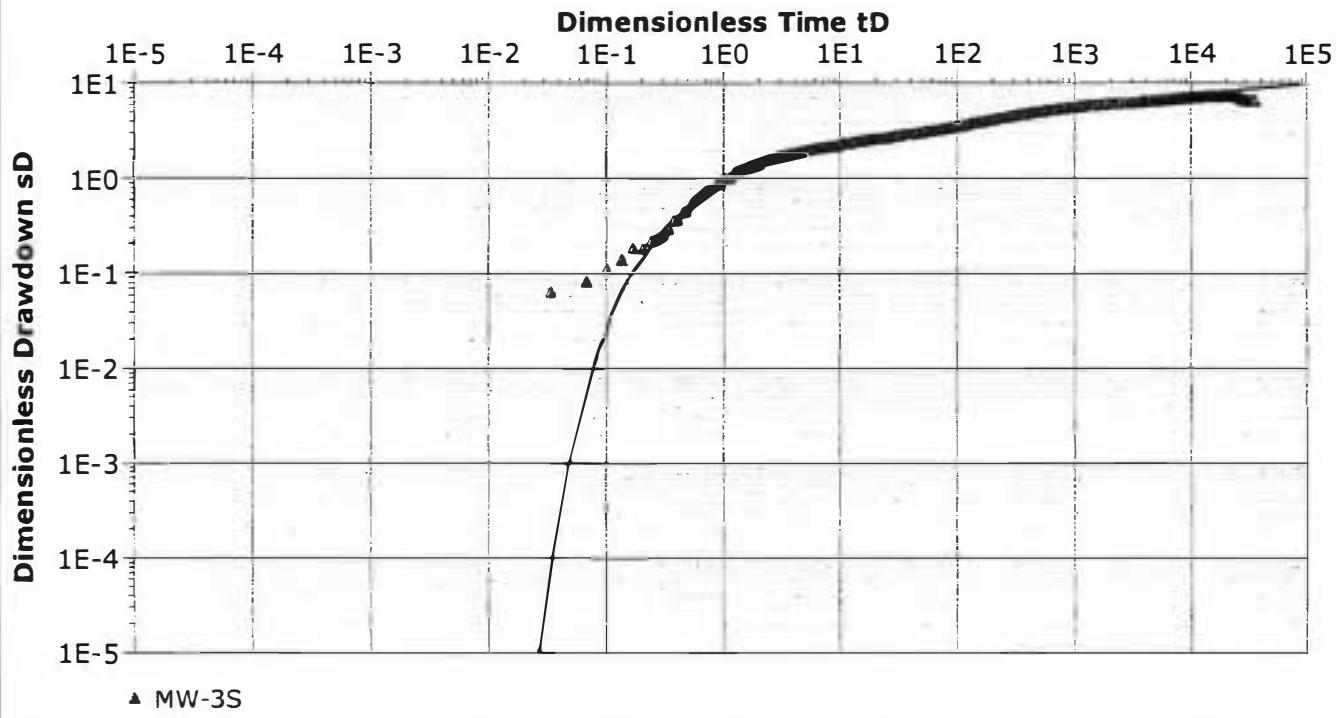
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Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1		Pumping Well: TW-1
Test Conducted by: Bade		Test Date: 4/28/2017	
Analysis Performed by: Bade	AS-8S Modified		Analysis Date: 7/17/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman

Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
AS-8S	4.77×10^4	1.01×10^3	1.47×10^{-1}	5.66×10^{-2}	1.67×10^1	59.89

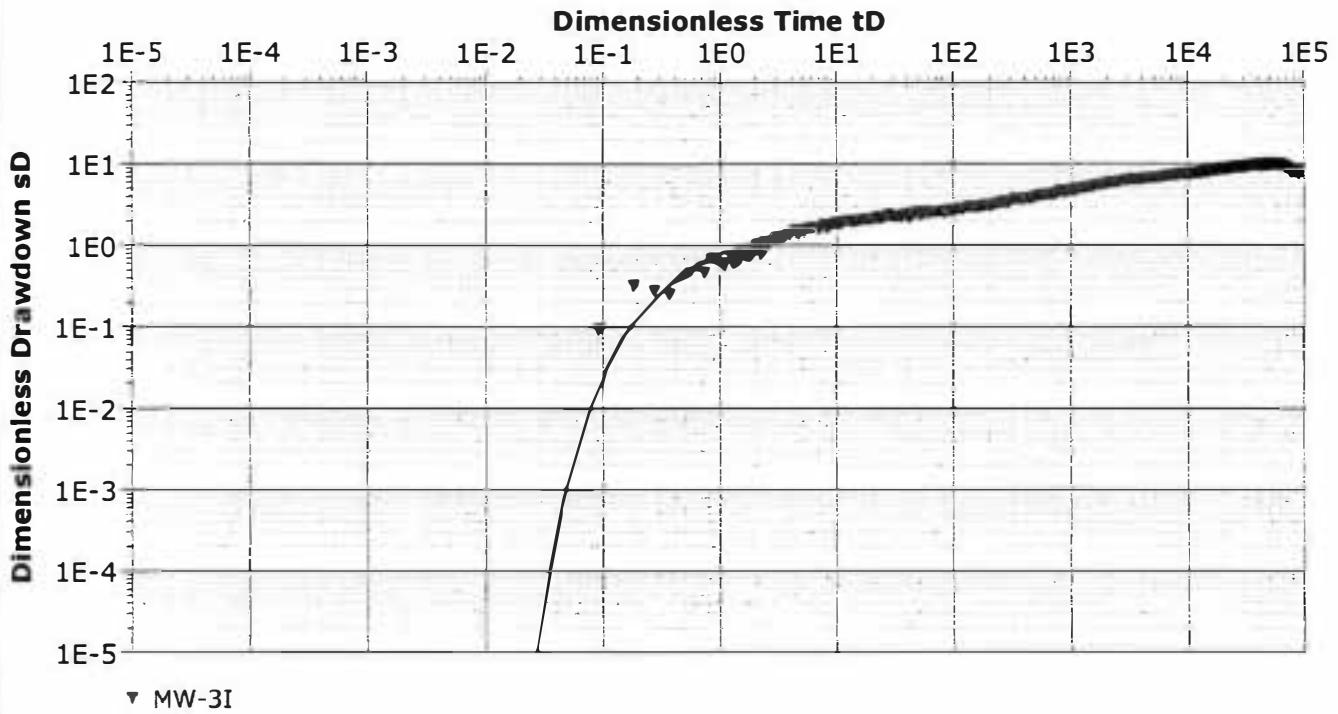
		Pumping Test Analysis Report	
Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1	
Test Conducted by: Bade		Test Date: 4/28/2017	
Analysis Performed by: Bade	MW-3S Modified	Analysis Date: 7/17/2017	
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman

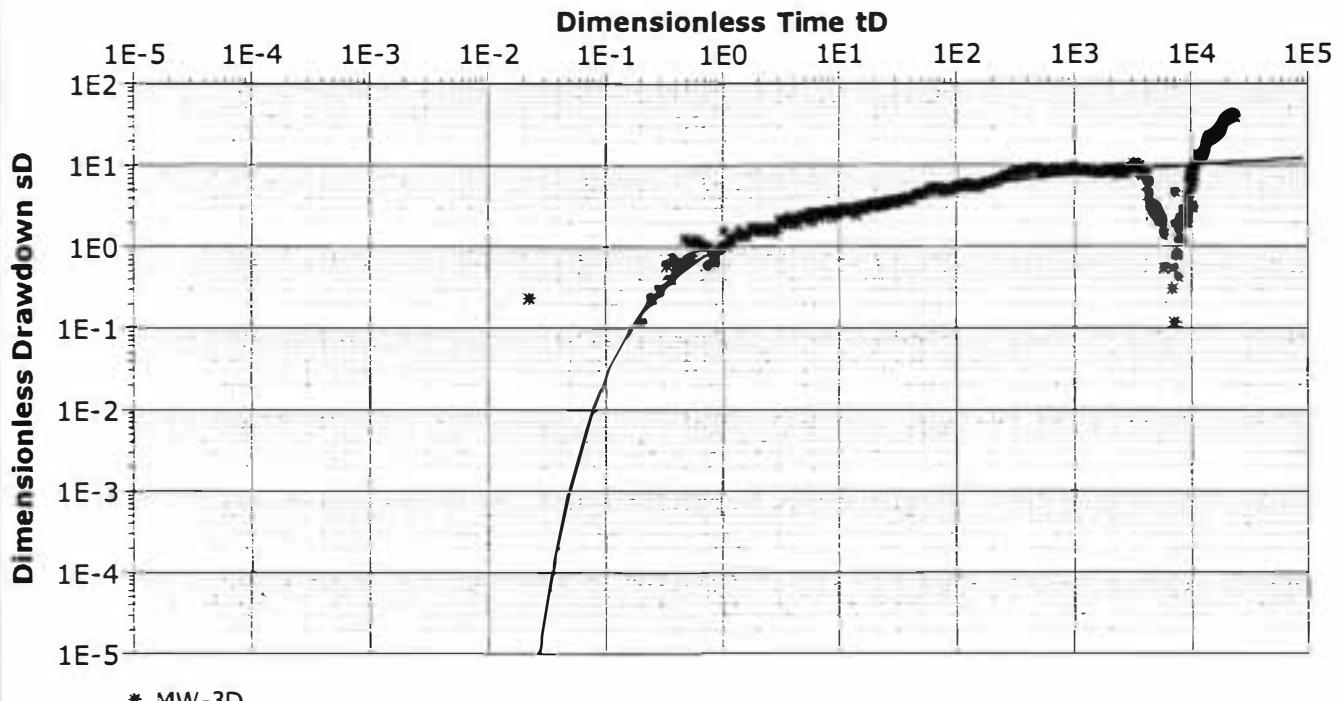
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
MW-3S	3.18×10^4	6.77×10^2	5.83×10^{-1}	1.00×10^0	1.15×10^1	7.28

		Pumping Test Analysis Report	
Project: LA Darling Pumping Test 2			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1	
Test Conducted by: Bade		Test Date: 4/28/2017	
Analysis Performed by: Bade	MW-3I Modified	Analysis Date: 7/17/2017	
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman						
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
MW-3I	8.13×10^4	1.73×10^3	6.86×10^{-1}	4.39×10^0	1.30×10^1	6.93

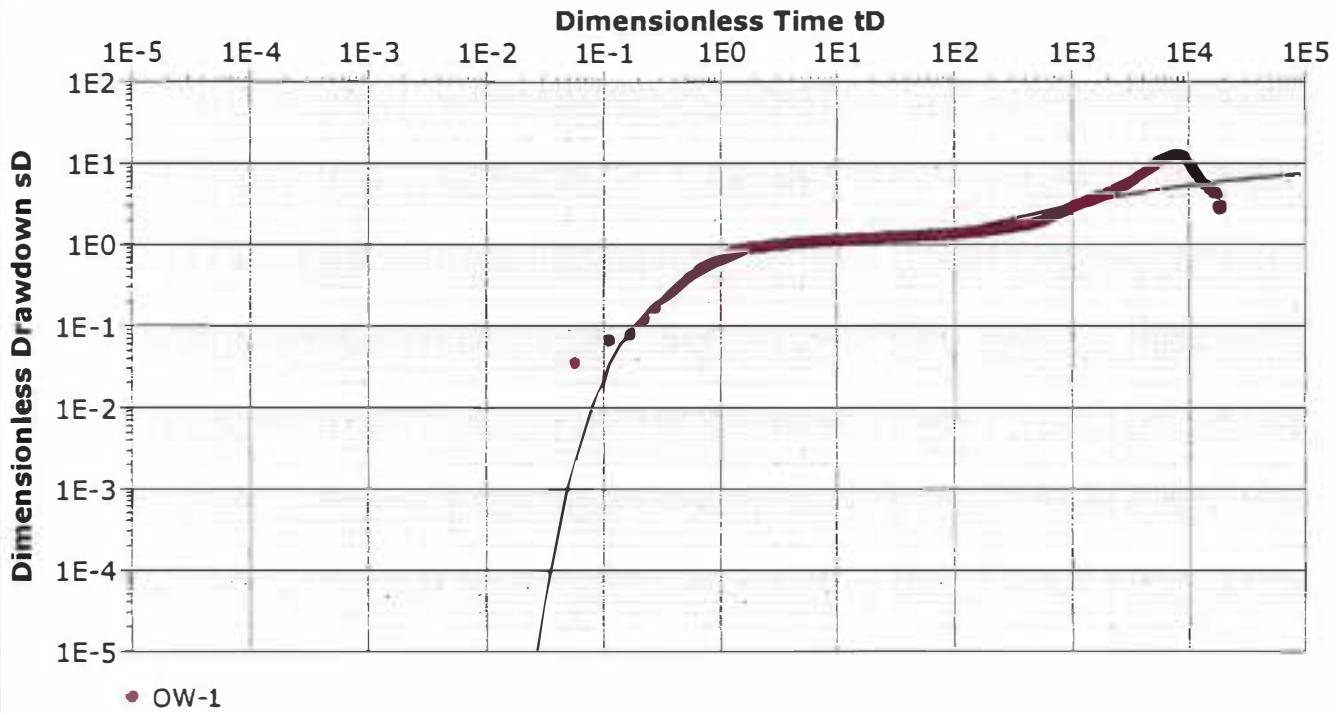
		Pumping Test Analysis Report	
		Project: LA Darling Pumping Test 2	
		Number:	
		Client: Darling Store Fixtures	
Location: Bronson, MI	Pumping Test: TW-1	Pumping Well: TW-1	
Test Conducted by: Bade		Test Date: 4/28/2017	
Analysis Performed by: Bade	MW-3D Modified	Analysis Date: 7/17/2017	
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman

Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
MW-3D	2.07×10^5	4.41×10^3	1.58×10^1	5.09×10^{-2}	1.39×10^1	4.85

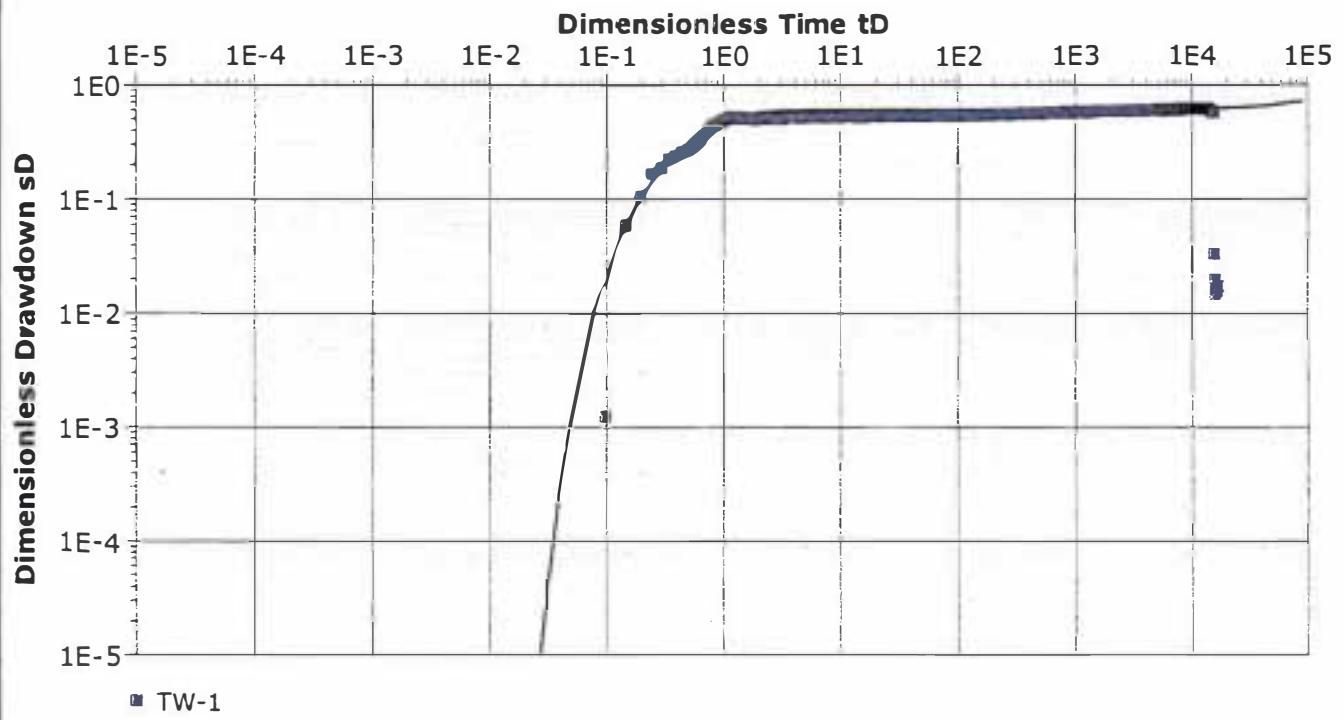
		Pumping Test Analysis Report
		Project: LA Darling Pumping Test 1
		Number:
		Client: Darling Store Fixtures
Location: Bronson, MI	Pumping Test: Pumping Test 1	Pumping Well: TW-1
Test Conducted by: Bade		Test Date: 8/1/2017
Analysis Performed by: Bade	OW-1, Modified	Analysis Date: 8/1/2017
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]	



Calculation using Neuman

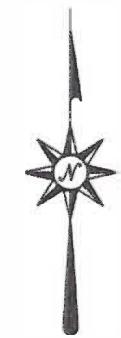
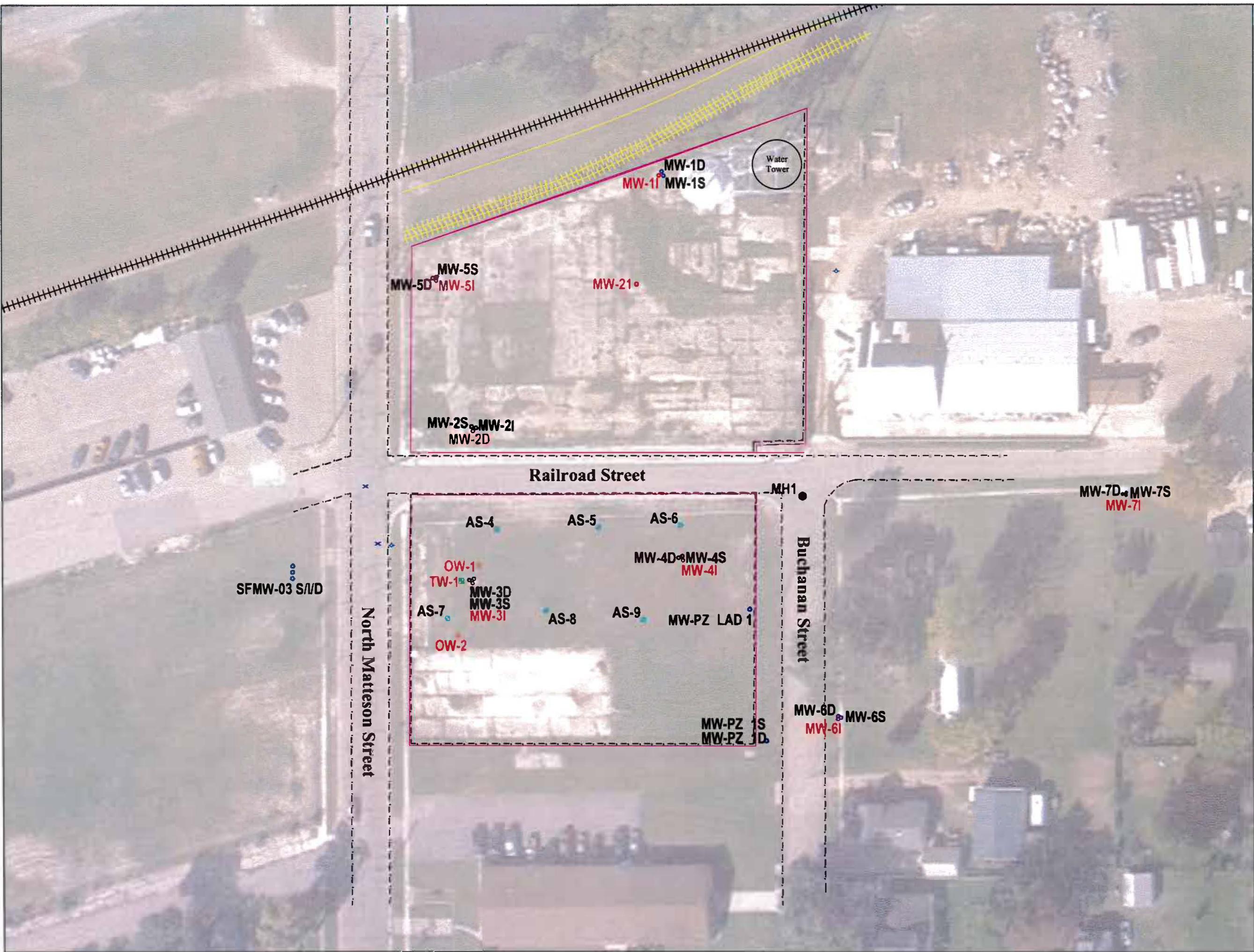
Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
OW-1	1.38×10^4	2.94×10^2	3.10×10^{-1}	2.21×10^0	1.00×10^2	15.21

		Pumping Test Analysis Report	
Project: LA Darling Pumping Test 1			
Number:			
Client: Darling Store Fixtures			
Location: Bronson, MI	Pumping Test: Pumping Test 1	Pumping Well: TW-1	
Test Conducted by: Bade		Test Date: 8/1/2017	
Analysis Performed by: Bade	Constant Rate 1,TW-1	Analysis Date: 8/1/2017	
Aquifer Thickness: 47.00 ft	Discharge Rate: 225 [U.S. gal/min]		



Calculation using Neuman

Observation Well	Transmissivity [ft ² /d]	Hydraulic Conductivity [ft/d]	Specific Yield	Ratio K(v)/K(h)	Ratio Sy/S	Radial Distance to PW [ft]
TW-1	1.07×10^3	$2.28 \cdot 10^1$	3.33×10^{-5}	1.00×10^4	5.74×10^5	0.33



Test Wells

Observation Wells

Monitoring Wells

Air Sarge Wells

Drawdown Observation Wells

Property Boundary

Railroad Track

Fence

60
0
60

Scale: 1" = 60'

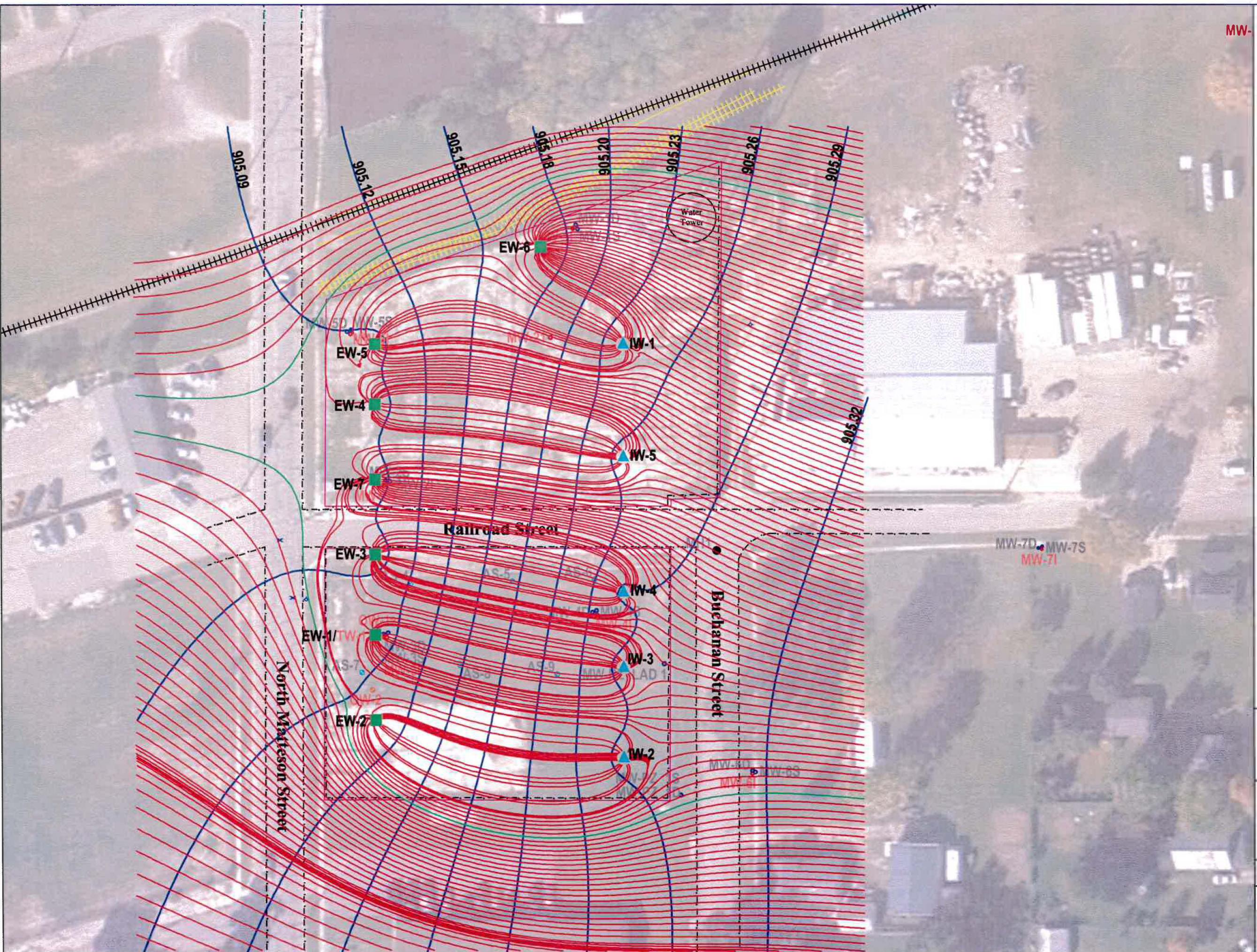
Figure 1

Site Map

**Former LA Darling
Facility - OU2
Bronson, Michigan**

reviewed by: CB September 2017

ASI ENVIRONMENTAL TECHNOLOGIES, INC.
Environmental Management Solutions, Inc., 2000-2010
410 East Dowland Street, Saginaw, MI 49731
Phone: 231.845.3771
Fax: 231.845.3723
www.environmental.com



EW - Extraction Wells
 7 Wells Pumping
 80 GPM - Total Dynamic Flow
IW - Injection Wells
 5 Wells Injecting
 50 GPM - Total Dynamic Injection Flow

Test Wells
Observation Wells
Monitoring Wells
Air Sparge Wells
MW Drawdown Observation Wells
Property Boundary
Railroad Track
Fence

60 0 60
Scale: 1" = 60'

Figure 2
Proposed Capture Zone-DRAFT

Former LA Darling Facility - OU2
Bronson, Michigan

reviewed by: CB September 2017

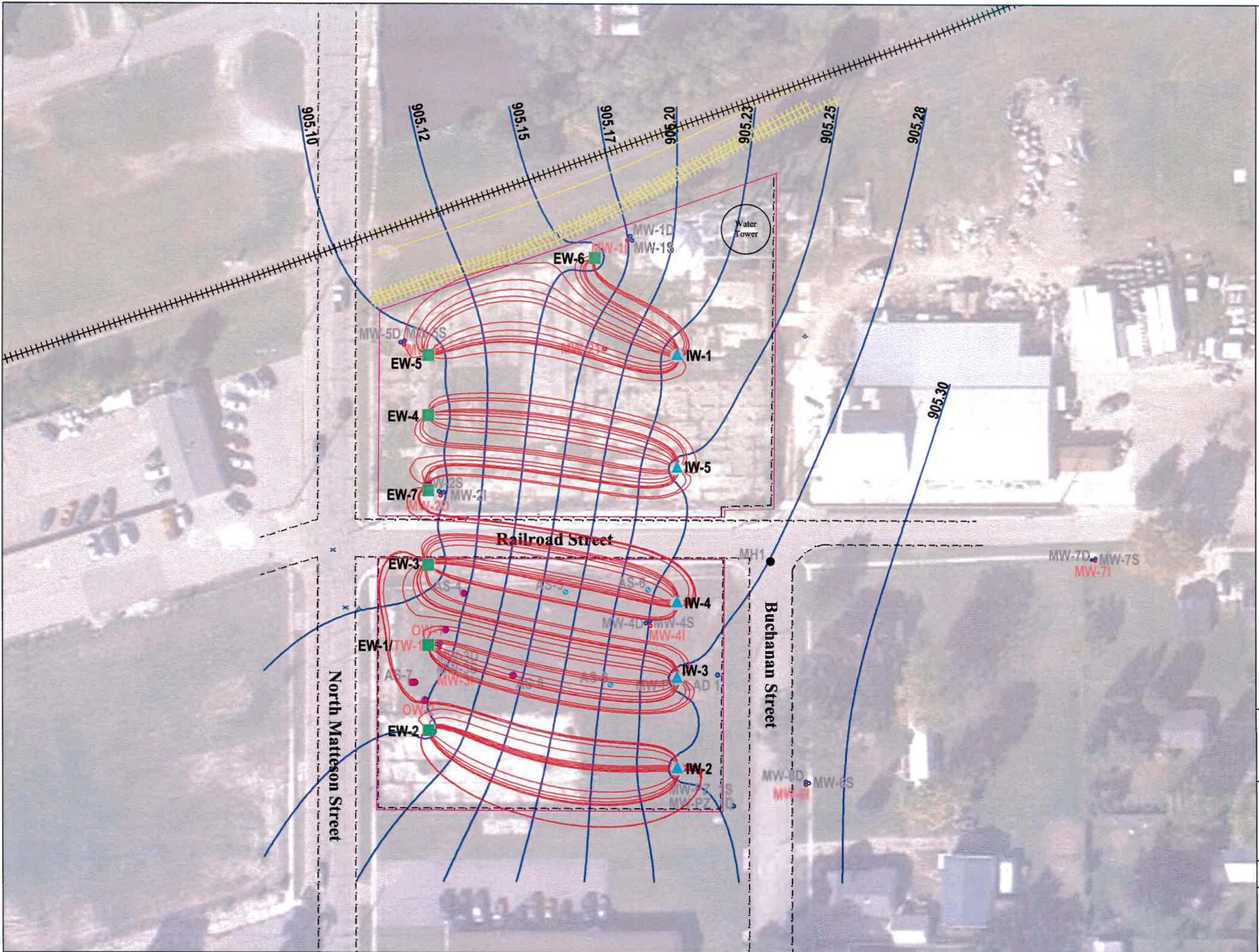


Figure 3
Injection Capture
Proposed Capture Zone-DRAFT

Former LA Darling
Facility - OU2
Bronson, Michigan

reviewed by: CB September 2017